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Examination Requested

(54) **Optical Disk Data Recording/Reproducing Apparatus and Method Thereof**

Abstract

The present invention relates to an optical disk recording/reproducing apparatus and method wherein any recording errors can be prevented by variably adjusting the recording speed of an optical disk recording/reproducing apparatus or temporarily delaying the recording process in a case where a buffer underrun phenomenon occurs due to an abrupt reduction in an process speed of a host system.

The data recording method using the optical disk recording/reproducing apparatus comprises the steps of assigning an amount of data remaining in a buffer to a plurality of addresses, and sending a notification signal to a microcomputer whenever the amount of data deviated from a predetermined value assigned to each address; turning off a laser power and increasing or decreasing a spindle motor speed so that a recording speed can be varied according to the notification signal, and then resuming a recording process after the speed becomes stable; and interrupting the recording process if a certain period of time lapses after the amount of data

in the buffer becomes less than the lowest value, whereby the recording speed can be variably adjusted according to a data transfer rate of a host system, and a buffer underrun phenomenon can also be prevented.

Representative Figure

Fig. 2

SPECIFICATION

Brief Description on the Drawings

Fig. 1 is a block diagram of a conventional optical disk recording/reproducing apparatus;

Fig. 2 is a block diagram of an optical disk recording/reproducing apparatus according to the present invention;

Fig. 3 is a block diagram of a buffer checker according to the present invention; and

Fig. 4 is a flow-chart showing a data recording method of the present invention.

Reference numerals on main portions of the drawings

10: disk	11: pickup device
12: signal generating unit	13: error signal generating unit
14: driving unit	15: servo signal processing unit
16: digital signal processing unit	17: audio signal processing unit
18: code conversion unit	19: microcomputer
20: host	21: interface unit
22: buffer	23: data modulating unit
25: power adjusting unit	25, 26: motors
27: buffer checker	28: multi-comparator

Detailed Description of the Invention

Object of the Invention

Technical Field to Which the Invention Belongs and Prior Art

The present invention relates to an optical disk recording/reproducing apparatus wherein any recording process interruption can be prevented by variably adjusting in advance a recording

speed or by delaying a recording process so that a buffer underrun phenomenon would not be produced while the recording process is performed.

As shown in Fig. 1, a conventional optical disk recording/reproducing apparatus comprises a pickup device 11 for reading or recording data from or into an optical disk 10; a signal generating unit 12 for shaping output data from the pickup device 11 and generating an REC parameter signal, an RF EFM signal and an ATIP sync signal; an error signal generating unit 13 for generating focus and tracking error signals based on the output data from the pickup device 11; a servo signal processing unit 15 for generating a servo signal based on output signal from the error signal generating unit 13; a digital signal processing unit 16 for decoding the servo signal from the servo signal processing unit 15 and outputting a servo control signal, and for decoding the EFM signal from the signal generating unit 12 and outputting the decoded signal; an audio signal processing unit 17 for converting the decoded EFM signal outputted from the digital signal processing unit 16 into an audio signal; a code conversion unit 18 for decoding the ATIP sync signal from the signal generating unit 12 and outputting the decoded signal, and for encoding and decoding a composite image signal and outputting the image signal; a driving unit 14 for receiving the servo signal from the servo processing unit 15, the servo control signal from the digital processing unit 16 and the decoded ATIP sync signal from the code conversion unit 18 and driving a motor 25 so as to rotate the optical disk 10 and for driving a motor 26 so that the pickup device 11 can be moved to perform focusing and tracking process of the pickup device 11; a microcomputer 19 for receiving the REC parameter signal from the signal generating unit 12 and the servo signal from the servo signal processing unit 15, and outputting the recording control signal, thereby controlling a system; a buffer 22 for receiving data from a host 20 via an interface 21 in response to instructions issued from the microcomputer 19 and outputting the data to an encoder of the code conversion unit 18; a data modulating unit 23 for modulating the composite image signal encoded by the code conversion unit 18 into recording data; and a power adjusting unit 24 for adjusting power for a laser such that the data from the data modulating unit 23 can be recorded onto the optical disk 10 through the optical pickup device 11 in response to the recording control signal from the microcomputer 19.

At the operation of conventional optical disk recording/reproducing apparatus constructed as mentioned above, in case of reading the contents recorded on the disk, the driving unit 14

drives the optical pickup unit 11 to read the data from the optical disk 10, which are then sent to the signal generating unit 12.

The signal generating unit 12 performs shaping operation of the data. This shaped data are sent to the digital signal processing unit 16 in which the data are converted into the EFM signal and the EFM signal is then decoded to produce 8-bit data. If the decoded data includes audio data, it is transmitted to the audio signal processing unit 17 to produce sounds. Otherwise, the decoded data is transmitted to a decoder of the code conversion unit 18 for decoding the data to produce ROM data.

Further, the optical pickup device 11 provides the error generating unit 13 with an error signal contained in the data read from the optical disk 10. The signal transmitted to the error generating unit 13 is then inputted into the servo signal processing unit 15 which allows the pickup device 11 to control various disturbing factors occurring at the time of accessing the disk.

On the other hand, in case of recording the data on the optical disk 10, the data, which is transmitted from the host 20 to the buffer 22 via the interface 21 under the control of the microcomputer 19, is encoded into the EFM signal by the encoder of the code conversion unit 24. Then, the encoded EFM signal is transmitted to the optical pickup device 11 via the data modulating unit 23 and the power adjusting unit 24, and then recorded on the optical disk 10.

At this stage, in order to maintain the optimal recording environment, the servo signal processing unit 15 sends various kinds of the control signals to the code conversion unit 18, the data modulating unit 23 and the microcomputer 19. The microcomputer 19 adjusts the power for the laser in response to the received control signal.

Furthermore, the microcomputer 19 identifies whether any data exists in the buffer 22. If any data exists in the buffer 22, the microprocessor causes the data to be recorded onto the optical disk 10. Otherwise, the microcomputer 19 turns the laser power off and issues an error message to the host 20.

However, the conventional optical disk recording and reproducing apparatus always performs the recording of the data at a constant recording speed when recording the data onto the optical disk 10. Thus, if a user selects a faster recording mode, all the data would be transmitted at a higher rate, and the host system would also load the data to be recorded onto the buffer at a rate corresponding to a higher transmission speed of the data. Also, since the

conventional optical disk recording/reproducing apparatus performs a real-time recording process, the laser power should not be turned off once the recording process begins. This means that turning off the laser could lead to damage the disk.

However, the data transmission speed of either the host system or a hard disk driver often becomes slow temporarily, which may cause the recording speed of the optical disk recording/reproducing apparatus to be unsatisfying. In such a case, it leads to a phenomenon of "Buffer Underrun" meaning that the inner buffer of the optical disk recording/reproducing apparatus remains empty. Then, the microcomputer turns the laser power off, and transmits an error message to the host computer. Thus, the recording process is stopped, leaving the disk damaged or destroyed. Therefore, all data recorded thus far will be lost.

Problems to be Solved by the Invention

Accordingly, the present invention is designed to solve the problem of the prior art. An object of the present invention is to provide an optical disk recording/reproducing apparatus and method wherein any recording errors can be prevented by adjusting a recording speed of the optical disk recording and reproducing apparatus or temporarily delaying a recording process in a case where a buffer underrun phenomenon occurs due to an abrupt reduction in an process speed of a host system.

Constitution and Operation of the Invention

According to an aspect of the present invention for achieving the above object, there is provided a data recording method using an optical disk recording/reproducing apparatus, comprising the steps of assigning an amount of data remaining in a buffer to a plurality of addresses, and sending a notification signal to a microcomputer when the amount of data deviates from a predetermined value assigned to each address; turning off a laser power in response to the notification signal and then resuming a recording process if the amount of data is greater than the lowest predetermined value within a predetermined time period; and interrupting the recording process if a certain period of time lapses after the amount of data in the buffer becomes less than the lowest value, whereby the recording speed can be variably adjusted according to a data transfer rate of a host system and a buffer underrun phenomenon can also be

prevented.

According to another aspect of the present invention, there is provided a data recording method using an optical disk recording/reproducing apparatus, comprising the steps of sending a notification signal to a microcomputer when an amount of data in a buffer becomes less than the lowest predetermined value; resuming a recording process if the amount of data is recovered above the lowest predetermined value within a certain period of time after turning off a laser power in response to the notification signal, and interrupting the recording process if a certain period of time lapses after the amount of data in the buffer becomes less than the lowest predetermined value.

According to a further aspect of the present invention for achieving the aforesaid object, there are an optical disk recording/reproducing apparatus, comprising a buffer; and a buffer checker for identifying an amount of data remaining in the buffer notifying a microcomputer when the amount of data becomes less than the lowest predetermined value.

Hereinafter, preferred embodiments of the present invention will be explained with reference to the accompanying drawings.

Fig. 2 shows a block diagram of an optical disk recording/reproducing apparatus according to the present invention.

As shown in Fig. 2, the present invention is configured such that a buffer checker 27 for identifying an amount of data remaining in a buffer 22 used in the conventional optical disk recording/reproducing apparatus is connected to the buffer 22.

The other components of the present invention are identical with those of the conventional optical disk recording/reproducing apparatus, and like elements having the same functions are denoted as reference numerals. Therefore, the detailed description thereof will be omitted. The buffer checker 27 is configured as shown in Fig. 3.

Namely, the buffer checker 27 comprises a multi-comparator 28, which generates a control signal for increasing or decreasing a recording speed based on the comparison of an address pointing to the most significant address for the data in the buffer 22 and the recording speed for the optical disk, or a control signal for stopping the drive of the laser power adjusting unit 24 when the host computer 20 is not properly operated.

The control signal from the multi-comparator 28 is sent to the microcomputer 19. When

receiving the control signal, the microcomputer 19 functions to adjust a speed of a motor 25 through the servo signal processing unit 15 and the drive unit 14 so that the recording speed is controlled or the laser power for the pickup device 11 is turned off by the laser power adjusting unit 24.

A process of controlling the data recording speed, based on the comparison in the multi-comparator 28 between the recording speed and the amount of data remaining in the buffer 22, will be described with reference to the flowchart of Fig. 4.

In the preferred embodiment, Smax shown in the flowchart denotes the highest normal recording speed; Smax/2 and Smax/4 denote 1/2 and 1/4 of the speed Smax, respectively; and Y1, Y2 and Y3 denote 80%, 40% and 20% of a total amount of data connected to a buffer 22, respectively, which can be stored in the buffer.

First, the initialization is made such that the recording speed inputted from the buffer checker 27 to the microcomputer 19 is set as a normal state of Smax1 and the amount of data in the buffer 22 is set to be greater than Y1 (S101).

Such an initialization is taken in consideration of the fact that the most significant address for the data in the buffer, which indicates the amount of data in the buffer 22, is always kept greater than Y1 at the speed of Smax, when the host system properly transmits the data to the buffer 22. That is, the initialization is made as a normal recording state. Thereafter, the microcomputer 19 checks whether the amount of data is less than Y1, in order to check whether the data transfer rate is lowered due to unexpected situations and the amount of data occupied in the buffer becomes less than a predetermined value (S102).

If the amount of data is greater than Y1, the steps following step S101 is executed. If the amount of data is less than Y1, the microcomputer 19 temporarily turns the laser power off and reduces the speed of the spindle motor 25 so as to reduce the recording speed to Smax/2. Then, after the speed of the spindle motor becomes stable, the recording process is resumed (S103).

After the motor speed is recovered, the microcomputer 19 checks whether the amount of data in the buffer is greater than Y1 (S104).

If the amount of data is greater than Y1, the recording speed is increased to Smax in the same manner as above (S105). Then, it returns to the step following step S101, and the

recording process resumed at the recording speed of Smax. However, if the data transfer rate is not recovered and the amount of data is less than Y1, it is checked in a next step S106 whether the amount of data is less than Y2. If the amount of data is less than Y2, it is returned to step S103. If the amount of data is less than Y2, the laser power is turned off and the speed of the motor 25 is decreased such that the recording speed is reduced to Smax/4 corresponding to the lowest speed in the preferred embodiment (S107), and then the recording process is resumed.

Subsequently, it is checked whether the data transfer rate of the host system is recovered and the amount of data is increased to a value greater than Y2 (S108). If the amount of data is greater than Y2, the laser power is turned off and the speed of the motor 25 is increased, thus, the recording speed is increased to Smax/2 (S109). Then, it is returned to the step following step S103 and the recording process is simultaneously resumed.

If the amount of data is not greater than Y2 in step S108, next step S110 checks whether the amount of data is less than Y3 and corresponds to the lowest state. If the amount of data is not less than Y3, it is returned to the step following step S107. If the amount of data is less than Y3, the microcomputer 19 causes the spindle motor to rotate while the laser power is turned off for a certain period of time. Then, if the amount of data still remains less than Y3 even after the certain period of time, it is regarded that the buffer underrun phenomenon has occurred due to an abnormal condition of the host system. Accordingly, the recording interruption is taken as the corresponding measures.

According to the optical disk data recording method of the preferred embodiment, since the recording speed can be variably adjusted in accordance with the data transfer rate of the host system, the recording error such as the buffer underrun phenomenon can be prevented without a significant reduction in the recording speed.

In the preferred embodiment of the present invention, an address associated with the interrupted recording process is stored in PMA (Program Memory Area) so that it may be possible to conduct an additional recording process for other areas subsequent to a specific area in which only the data currently operated are corrupted. Therefore, although the data currently recorded in the specific area is corrupted, the other areas subsequent to the specific area can be used for the additional recording of the data.

This preferred embodiment is configured to prevent the buffer underrun phenomenon by

variably adjusting the recording speed according to the amount of data remaining in the buffer. On the other hand, according to another preferred embodiment, if the amount of data remaining in the buffer is small enough to cause dangerous conditions, the data transfer rate of the host system is checked in a state where the recording speed remains unchanged but the laser power is turned off. Then, if a normal data transfer rate is recovered within a certain period of time, the interrupted recording process is immediately resumed. Further, if the data is still not transferred even after the certain period of time, the microcomputer performs the same measures as mentioned above.

Effect of the Invention

According to the optical disk recording/reproducing apparatus and method of the present invention as described above, the amount of data remaining in the buffer is checked and then the recording speed etc. are adjusted in accordance with the checked amount of data. Thus, the recording process can be controlled so that the recording speed is variably adjusted according to the data transfer rate of the host system or the recording process would be temporarily delayed. Therefore, there is an advantage in that the buffer underrun phenomenon can be avoided, preventing the disk from being destroyed or damaged.

(57) Claims

1. A data recording method using an optical disk recording/reproducing apparatus, comprising the steps of:

assigning an amount of data remaining in a buffer to a plurality of addresses, and sending a notification signal to a microcomputer whenever the amount of data deviates from a predetermined value assigned to each address;

turning off a laser power and increasing or decreasing a spindle motor speed so that a recording speed can be varied according to the notification signal, and then resuming a recording process after the speed becomes stable; and

interrupting the recording process if a certain period of time lapses after the amount of data in the buffer becomes less than the lowest value,

whereby the recording speed can be variably adjusted according to a data transfer rate of a host system and a buffer underrun phenomenon can also be prevented.

2. The method as claimed in Claim 1, wherein the recording speed is adjusted to half the current speed or double the current speed whenever the amount of data deviates from the predetermined value.

3. The method as claimed in Claim 1, further comprising the step of storing an address associated with the interrupted recording process into a PMA.

4. A data recording method using an optical disk recording/reproducing apparatus, comprising the steps of:

sending a notification signal to a microcomputer when an amount of data in a buffer becomes less than the lowest predetermined value;

resuming a recording process if the amount of data is recovered above the lowest predetermined value within a certain period of time after turning off a laser power in response to the notification signal, and

interrupting the recording process if a certain period of time lapses after the amount of data in the buffer becomes less than the lowest predetermined value.

5. An optical disk recording/reproducing apparatus, comprising:

a buffer; and

a buffer checker for identifying an amount of data remaining in the buffer notifying a microcomputer when the amount of data becomes less than the lowest predetermined value.

Fig. 1

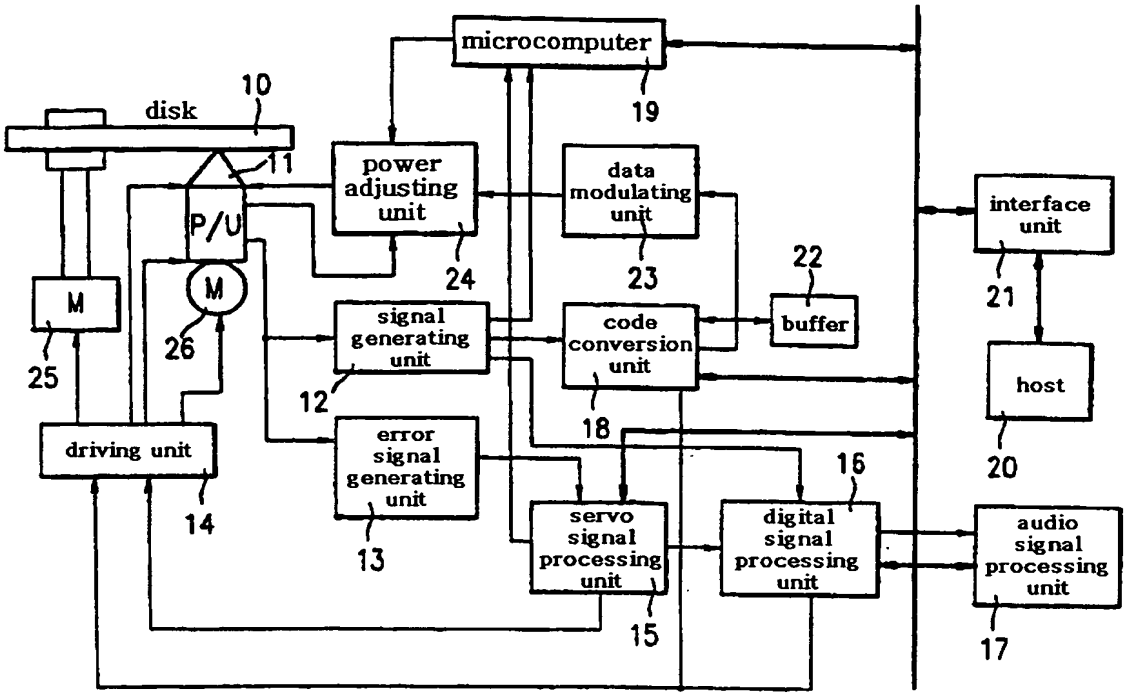

microcomputer
19
disk
10
11
power adjusting unit
24
data modulating unit
23
interface unit
21
P/U
M
26
M
25
signal generating unit
12
code conversion unit
18
22
buffer
host
20
driving unit
14
error signal generating unit
13
servo signal processing unit
15
16
digital signal processing unit
audio signal processing unit
17

Fig. 2

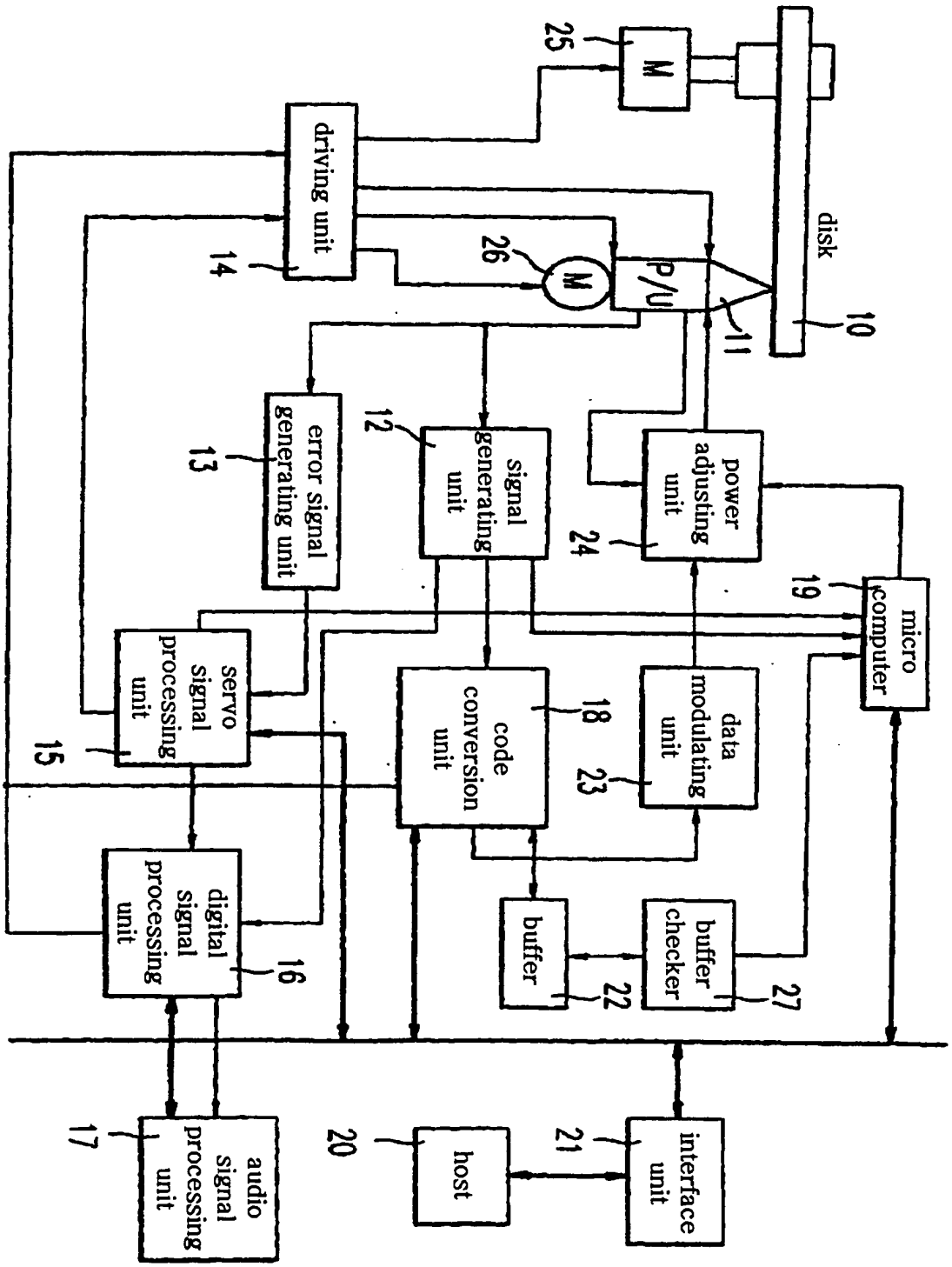

disk
10
P/U
11
M
25
M
26
driving unit
14
error signal generating unit
13
signal generating unit
12
power adjusting unit
24
micro computer
19
servo signal processing unit
15
code conversion unit
18
data modulating unit
23
digital signal processing unit
16
buffer
22
buffer checker
27
audio signal processing unit
17
host
20
interface unit
21

Fig. 3

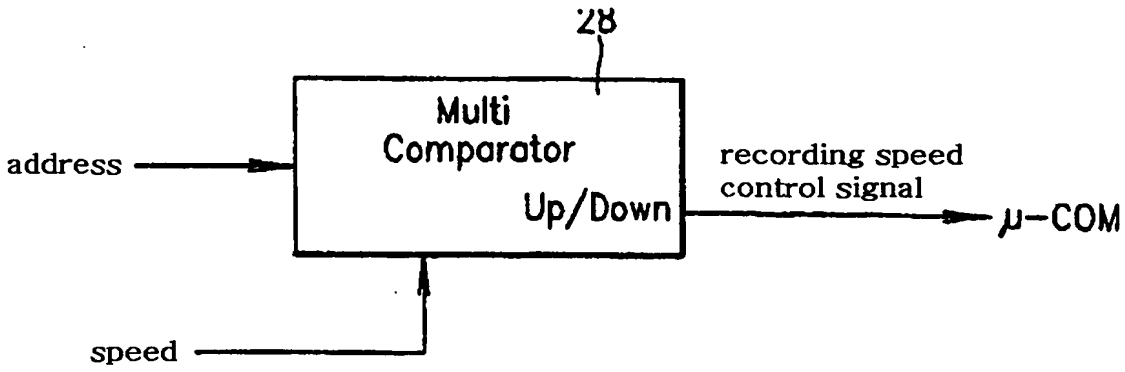
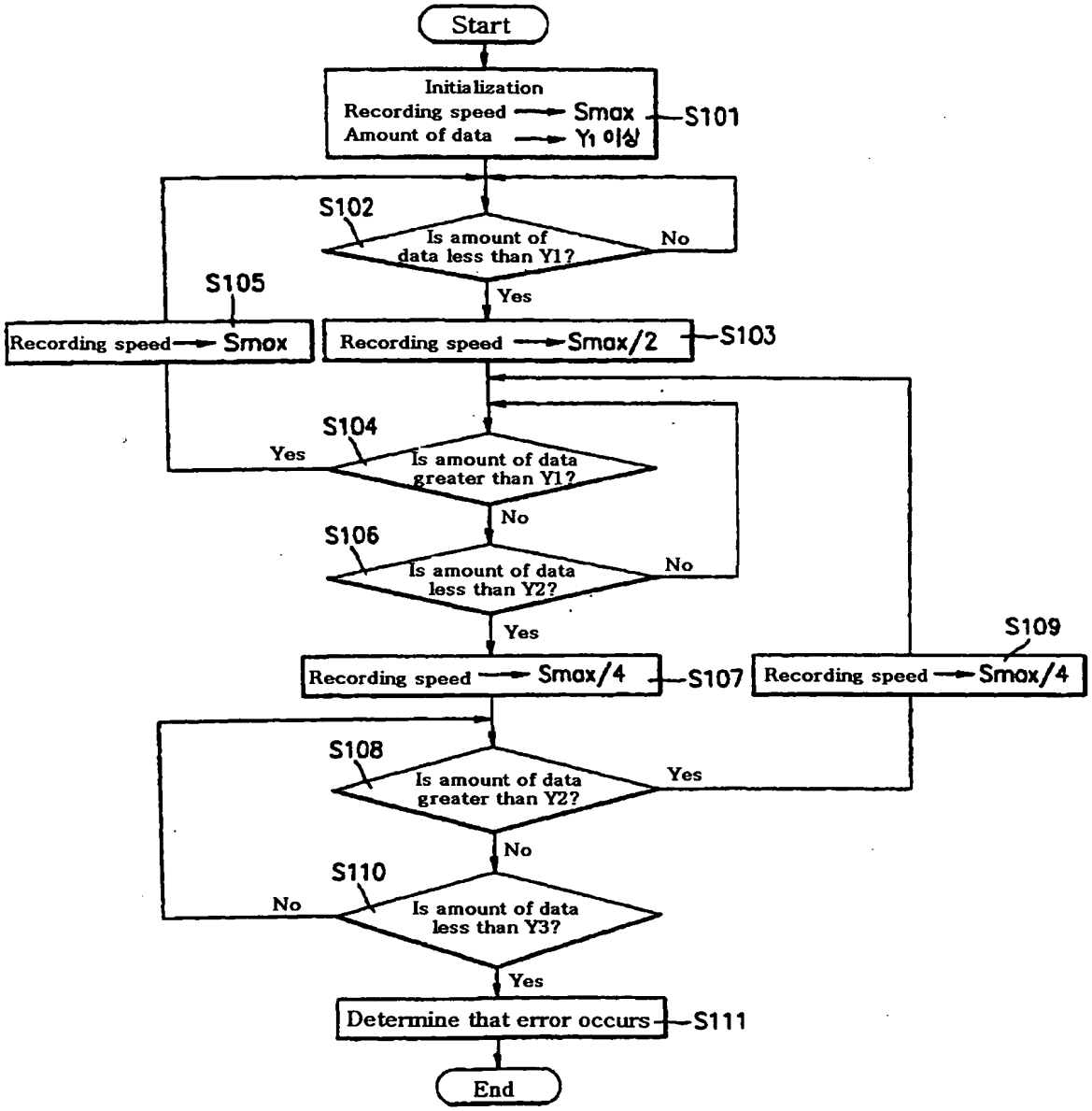

28
Multi
Comparator
Up/Down
address
speed
recording speed
control signal
μ-COM

Fig. 4


Start
Initialization
Recording speed → Smax
Amount of data → Y1 이상
S101
S102
Is amount of data less than Y1?
No
Yes
S105
Recording speed → Smax
Recording speed → Smax/2
S103
S104
Yes
Is amount of data greater than Y1?
No
S106
Is amount of data less than Y2?
No
Yes
S109
Recording speed → Smax/4
Recording speed → Smax/4
S107
S108
Is amount of data greater than Y2?
Yes
No
S110
No
Is amount of data less than Y3?
Yes
Determine that error occurs
S111
End